flows within banks. Consequently, available storage was utilized and included in the hydrologic models for low-lying overbank areas. Therefore, a floodplain management program should be implemented that preserves the floodwater storage capacity of these areas.

8.3 REAL ESTATE

In estimating real estate costs, the current assessed value for the structures to be acquired in fee simple is used as a base. CELRL Appraisal Branch personnel obtained sales data and estimated an appropriate factor for increasing value. Vacant land sales data were obtained to estimate a value applied to each classification of vacant land (residential, industrial, and commercial). In this screening process, no analysis has been performed for value of land or structures within the floodplain as opposed to those outside the floodplain. An administrative cost has been included for the government and for MVCD (provided by Robert V. Jansen).

8.4 ENVIRONMENTAL

Screening attributes, or features of the study area, that represent possible constraints on the development of the individual flood control alternatives have been identified for evaluation. The attributes were identified based on environmental, engineering/construction, cultural, and land use characteristics that require evaluation as part of the National Environmental Policy Act (NEPA) process in the review of other environmental regulations and programs.

In order to collect, present, and evaluate the attributes, digital constraint maps were prepared that display the environmental, land use, engineering/construction, and cultural attributes for the study area. A base map was prepared using a mosaic comprising Geographical Information System (GIS) coverage available for the flood control project area, the USGS 7.5-minute topographic quadrangles, and other relevant graphical information sources. The information on the map was checked and updated using digital aerial photography and field reconnaissance. Updates include the addition or deletion of structures; water bodies; and residential, commercial, and industrial areas.

Ecological attributes have been identified based on applicable state regulations and the Federal Endangered Species Act. The following attributes were considered as environmental constraints in the screening process:

- Woodlands and forests
- Known wetland areas
- Surface waters
- Recorded threatened and endangered (T&E) species locations
- Established nature preserves, refuges, wildlife management areas, etc.

Wetland data were collected from published National Wetlands Inventory (NWI) Maps, as well as other federal, state, and local resource agencies. Information on T&E species and natural features was collected from the ODNR Division of Natural Areas and Preserves and the USFWS. Natural features have no regulatory protection but are considered to be environmentally unique.

Land use attributes have been identified as a component of this program. The following attributes were considered as land use constraints in the siting process:

- Sensitive land uses (e.g., recreational areas, airstrips, communication facilities)
- Institutional land uses (e.g., churches, schools, preschools, hospitals)
- Housing, including residential subdivisions and mobile home parks
- Dense urban developments, including industrial and commercial areas

After the study area was delineated, a land use survey of the area was conducted noting land uses. County planning authorities were contacted, and local planning documents were reviewed to ensure a proposed project would not impact any identified future land use development.

Cultural attributes have been identified based on applicable federal and state regulations. The following attributes were considered as cultural constraints in the siting process.

- Archaeological sites
- Sites on the Ohio Historical Inventory
- Sites on the NRHP
- Cemeteries

Recorded archaeological and Ohio Historical Inventory sites were collected from the State Historic Preservation Office (SHPO). Properties on the NRHP were obtained from the National Park Services electronic database.

All relevant ecological, land use, and cultural information was transferred to the base map. The information contained on the base map has been reviewed and compared during the screening of the potential flood control alternatives. The primary focus is to identify potential alternatives that, to the extent possible, avoid constraints described above or minimized impacts where they could not be avoided.

8.5 ECONOMICS

Flood damage data from the 1996-1997 economic update was utilized in screening of alternatives for Mill Creek described in this report. The June 1997 report of the economic update was not an approved official document. However, that effort was conducted in a Feasibility Study level-of-detail, the floodplain is considered fully developed, and there is no significant change in the study area. Accordingly, it was felt that the June 1997 data were sufficient for this screening of alternatives. It should be noted that completely updated Feasibility-level economics will be pursued in subsequent stages of economic analysis for the GRR.

Flood damage surveys were performed during 1996 and early 1997 within the 0.2% chance floodplain of Mill Creek from the Barrier Dam to the Butler County line. For economic analysis purposes, the study area is divided into 11 sections which coincide with the construction sections for the authorized alternative. There are nine existing levees in the study area that are

located in sections 6, 7A, and 7B. These levees were privately constructed and provide various degrees of protection to approximately 60 structures in commercial and industrial areas. The levee features and the project performance for a 1% chance flood were studied and reported in 1997. The information contained in the report was utilized when determining flood damages.

The historical 0.2% chance floodplain (pre-1980) were delineated on maps to show the areas and structures subject to flooding. Physical damages within the 0.2% chance floodplain were classified by the following categories: single family and multifamily residential, commercial (including industrial), public facilities, and roads and utilities.

Information for more than 1,700 structures in the study area was gathered. The majority of structure first-floor elevations were estimated using the detailed mapping. However, the first-floor elevations of the majority of the commercial properties within section 7B were determined by land-survey methods by the CELRL. The MVCD provided estimates of first-floor elevations and structural characteristics data attributed to over 1,200 of the residential structures. The majority of the residential structure values in the study area were obtained from property valuation data. Values for remaining residential structures were estimated from County and City Data Book information, which is issued by the Bureau of the Census.

Federal Emergency Management Agency (FEMA) National Flood Insurance Administration (FIA) depth-damage functions were used to estimate expected damage to both single and multifamily residential properties for depths of flooding up to the estimated 0.2% chance flood event. Content-to-structure values (ranging from 40.2% to 44.1%) for various structure types was based on FIA damage claims data as provided in EM 1110-2-1619. Damage to non-residential properties was based on interviews with owners and/or managers of facilities in the floodplain. When damage information for properties was not available from representatives of facilities, estimates were made based on experience with similar properties.

The Flood Damage Analysis (FDA) computer program, developed by the HEC, was utilized in calculating structure damage estimates. The FDA program calculates the expected annual damage for the Without-Project alternative and each alternative With Project. The economic analysis took into account damages that would be incurred up to the 0.1% chance flood event. The flood events were based on the current hydrology & hydraulics input for both existing and future (2015) hydrology.

The FDA program incorporated a method for accounting for uncertainties (potential over/underestimating) in estimates of major economic variables, such as structure first-floor elevations, structure values, structure-to-content value ratios, and depth-damage functions. The FDA program used the length of record of the gage, 56 years on Mill Creek and 84 years on the Ohio River, in calculating the uncertainty associated with the hydrology and hydraulics input variables. When calculating uncertainty associated with the hydrology and hydraulics stage discharge functions, the FDA program used the standard deviation of the error of the stage where the error becomes constant. Uncertainties in cost estimates were accounted for by the traditional method of applying contingency factors.

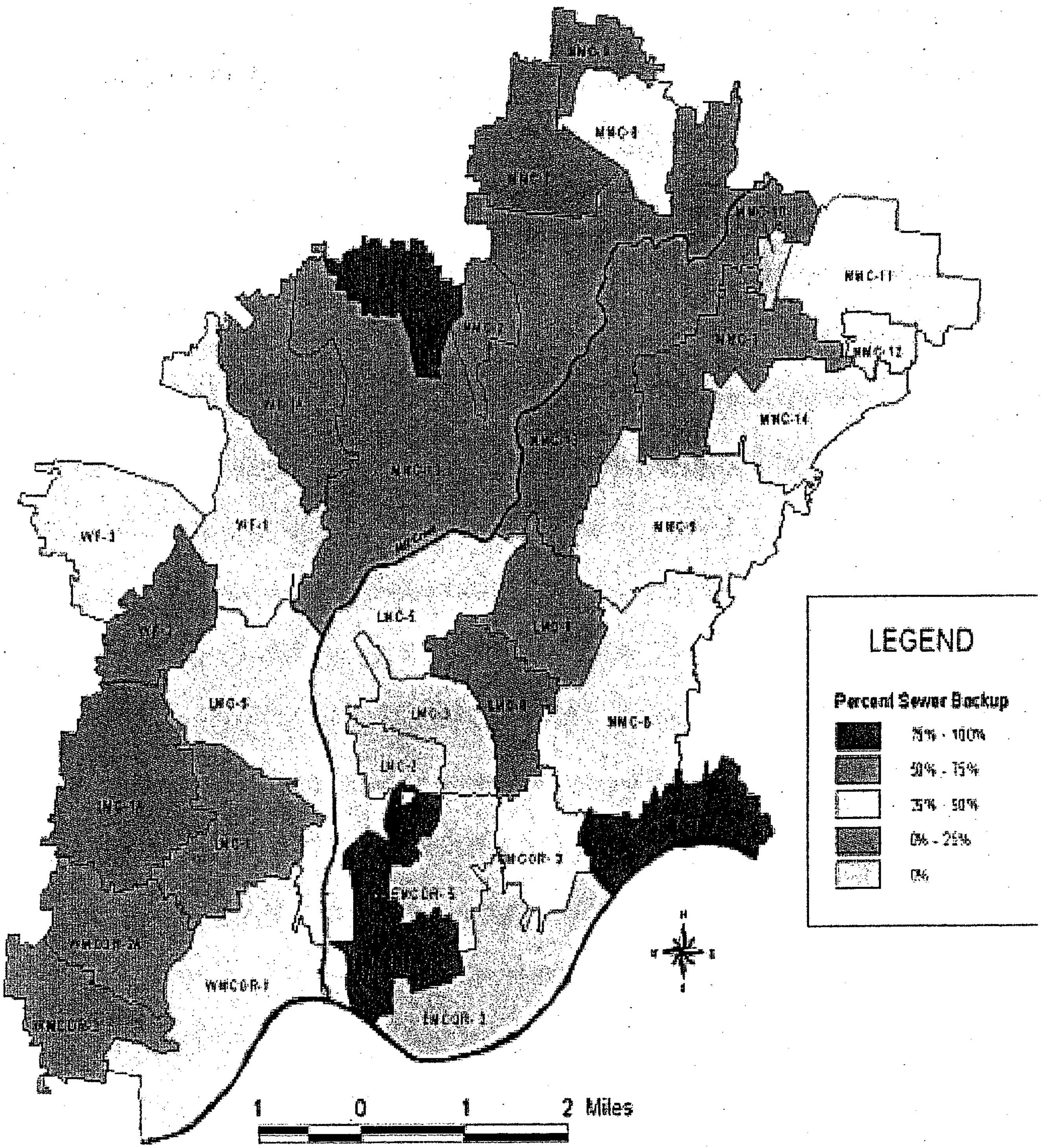
The economic analysis also takes into account the damages caused by sewer backup into basements. For the screening exercise, the overall Mill Creek Watershed was divided into roughly 30 separate sewered areas. Data drawn from the Cincinnati Area Geographic Information System (CAGIS) were used to map structure and sewer information for these areas. A comprehensive survey consisting of telephone interviews was then undertaken to establish the characteristics of flooding; including flooding experience, flooding frequency, impacts to vehicular movements, monetary damages experienced and allied topics. A total of 2,400 interviews based on random sampling were completed. The statistics generated from the sample were applied to the population of single-family homes to estimate the total value of sewer backup flooding damages. It should be noted that damages to multi-unit structures, and commercial, industrial, and public structures were not included, therefore the damages presented at the screening level are conservative.

Should alternatives which could reduce the incidence of basement sewer backup damages be selected for additional study, a more detailed analysis of these damages will be undertaken (See Figure 8.5.1, Sewer Backup Map). This will take into account such additional information as sewer discharge volumes and surcharges, flood elevations, and structure and basement elevations.

The economic benefit of a With-Project alternative is the reduction in damages when compared to the Without-Project alternative. Therefore, the average annual benefit for each alternative was calculated by taking the difference between the average annual damage for the Without-Project alternative and the average annual damage for the With-Project alternative.

The economic feasibility of an alternative was determined by comparing the benefits to the costs. If the benefit to cost ratio (BCR) was greater than 1.0, the alternative was economically justifiable. For this analysis, the average annual cost of an alternative was determined by considering a number of factors, including construction cost, length of construction period, interest during construction, and O&M costs. The costs were annualized using a discount rate of 5.875% and a project life of 50 years. The average annual cost for an alternative was subtracted from the average annual benefit to compute the net annual benefit.

FIGURE 8.5.1


MMC-11
MMC-14
MMC-9
LMC-5
LMC-3
LMC-2
MMC-6
LEGEND
Percent Sewer Backup
75% - 100%
50% - 75%
25% - 50%
0% - 25%
0%
1 0 1 2 Miles

Completion of each alternative occurs in different years, ranging from 2009 to 2016. The year following construction was considered the alternative's base year. In order to account for the 50-year project life of each alternative, the Without-Project damages were adjusted to take into account the alternative base year. In order to provide an equal comparison of alternatives, a project base year of 2010 was selected. The results of alternatives estimated to be completed after 2010 were discounted using a rate of 5.875%. The economic price level used in this screening-level analysis was October 2002.

Non-physical costs often result from a flood event. These include the cost to provide emergency services and the cost of diverting traffic when streets are impassable. These cost categories were not evaluated for this screening-level analysis. Non-physical costs will be further evaluated in Stage 3.

Implementing an alternative can often cause either positive or negative impacts to the environment. Quantifying and placing a monetary value on the environmental impacts was not undertaken during this screening-level analysis. Policies and guidelines will be evaluated for inclusion in Stage 3.

9. ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD

Over the years many alternatives have been formally and informally proposed to alleviate the flooding problems along Mill Creek. These include both non-structural and structural measures. However, after studies and consideration it was found that many of these alternatives were not viable options and were subsequently dismissed — hence, they were not considered in this screening evaluation. One type of alternative which was given particular review in recent years was the use of detention ponds.

It was realized early in the prior GRR that detention basins could play an important role in the formulation of alternative. Considerable thought was given to constructing a few large detention basins in Butler County to provide protection downstream in Hamilton County. However, because of the rapid development of the floodplain in Butler County, it became apparent that these sites were no longer available for flood control storage. Consequently, other detention basin sites within Butler County and Hamilton County with lesser amounts of storage were studied. Shown below are some of the detention basin sites considered during the prior GRR evaluation in 1998-2000:

Detention Basins evaluated

a. Mill Creek in Butler County from just upstream of I-75 to just downstream of Rialto Road.

b. Mill Creek in Butler County from just downstream of Highway 747 to just downstream of Seward Road.

c. A tributary to Mill Creek in Butler County from upstream of Seward Road to downstream of Gilmore Road.

d. The Port Union Tributary to Mill Creek in Butler County upstream of Port Union Road.

e. Mill Creek in Butler County between Windisch Road and I-75.

f. East Fork Mill Creek in Butler County upstream of Allen Road to downstream of Rialto Road.

g. East Fork Mill Creek in Butler County just upstream of the community of West Chester.

h. The West Chester Tributary to East Fork Mill Creek in Butler County upstream of I-75.

i. Sharon Creek in Hamilton County downstream of Sharon Lake.

j. Existing detention basin tributary to Sharon Creek in Hamilton County. (Increase storage capacity.)

k. Cooper Creek (Evendale Tributary) located in Hamilton County upstream of Reading Road.

l. Located between Mill Creek and East Fork Mill Creek upstream of their confluence in Hamilton County.

m. Mill Creek just upstream of railroads near Sharon Creek and downstream of Medallion Drive in Hamilton County.

n. Mill Creek in Hamilton County just upstream of Formica and downstream of Glendale Milford Road.

o. Mill Creek in Hamilton County downstream of Formica and upstream of General Electric.

p. Mill Creek in Hamilton County downstream of Columbia Street at Koening Park.

Detention basin sites (a) through (j) were not feasible because either the lands were no longer available due to existing or proposed development, the detention basins did not have enough capacity to reduce the flows in the study area, or the basins were located too far upstream to have an impact in Hamilton County. (Many of these detention basins would have a significant impact on flows in Butler County but only slight reductions in flow for Hamilton County.) The remaining detention basins were later dismissed from further study based upon engineering and economic evaluation. Hence, detention basins were not included in the alternatives considered in this report's evaluations.

10.0 DESCRIPTION AND EVALUATION OF ALTERNATIVES

This section presents the alternatives that were evaluated and the results of those evaluations. The Without-Project (baseline) alternative and nine With-Project alternatives were analyzed. The With-Project alternatives considered for analysis were: total relocation (RL), non-structural (NS), non-structural 2 (NS-2), non-structural 3 (NS-3), channel modification (CM), channel modification 2 (CM-2), floodwall/levee (FW), deep tunnel (TU), and deep tunnel 2 (TU-2).

10.1 WITHOUT-PROJECT ALTERNATIVE

10.1.1 Description and Features

The Without-Project (WO) alternative is the baseline or "No Action" alternative; it provides a common base of comparison for all other alternatives. This alternative includes features and other conditions that would likely come about, even without Federal involvement or funding. The WO alternative assumes that most of Mill Creek (including both the unimproved and previously improved sections) would remain as it is today. The previous channel modifications are described in Section 5.1. No additional USACE flood control structures would be implemented. Complete maps showing the creek, buildings, and infrastructure along the creek (per the WO alternative) can be found in Appendix VI.

It is expected that over time, limited ecosystem restoration of a few floodplain areas would be undertaken (e.g., creation of small hardwood wetland areas) through programs and grants initiated by the MCRP or others. However, for purposes of this GRR, under the WO alternative, no specific ecosystem restoration would be recommended as a Federal action.

A Flood Warning System (FWS) will be implemented by CELRL in July 2003 to alert businesses and residences about a potential flood. After implementation, the MVCD will be responsible for the O&M costs.

10.1.2 Hydrology & Hydraulics

The hydrology and hydraulics analysis has been described under Existing Conditions (Chapter 5) and the Methodology (Chapter 8). The WO alternative would not change these conditions. The water surface profiles for the existing and future conditions are shown in Appendix IV.

10.1.3 Environmental

According to the Mill Creek Greenway Master Plan (June 1999), limited riparian planting would be undertaken by the Mill Creek Restoration Project (MCRP) or others. The planned limited planting of riparian buffer areas only along the mainstem would result in some increase in stabilization of the riparian bank edges. Along with stabilization, these riparian plantings would enhance and create terrestrial habitats on top of the bank for birds, mammals, amphibians, and reptiles. Over time the terrestrial habitat improvements would result in more available forage, nesting/roosting, and concealment opportunities to endemic wildlife of the area.

In addition, the riparian plantings on the top of banks would create vegetated shaded banks that would result in a decreased thermal burden to aquatic species within the vegetated sections of the mainstem. As a part of the revegetation effect, plant biomass would be increased, providing forage materials and substrate structure suitable for macroinvertebrate species, thereby increasing the macroinvertebrate populations. This process would provide an enhanced food source for fish and other aquatic life species.

Water quality improvements would result from the reduction of CSOs entering Mill Creek. CSO issues would be addressed by the Metropolitan Sewer District's (MSD's) CSO reduction plan. CSOs at over 100 locations would be reduced through a total of approximately 85 capital improvement projects. These projects include the construction of high-rate treatment facilities, regulator improvements, pump stations, and sewer separation projects. The initial cost of this plan was estimated to be $279 million over 25 years. Refer to the *Mill Creek CSO Reduction Plan, in lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002) for design and cost analysis.

The CSO improvements would provide a significant reduction in the volume of CSOs and associated pollutant loads. The proposed CSO reduction plan provides controls for 86% of the average annual combined sewage flow. The plan would reduce the average annual volume of CSOs entering Mill Creek from 3,635 million gallons per year (MG/yr) to 730 MG/yr.

The CSO reduction plan also includes a monitoring and modeling component to ensure that water quality objectives are being met. When CSO reduction is combined with other TMDL strategies, it was anticipated that water quality in Mill Creek would improve, eventually meeting the standards for MWH designation in the lower sections and WWH designation in the upper sections of the project area.

10.1.4 Economics

10.1.4a Cost Analysis

The WO alternative assumes that most of Mill Creek (including both the unimproved and previously improved sections) would remain as it is today. The previous modifications are

described in Section 5.1. Because no substantial construction work would be undertaken, there are no substantial costs associated with this alternative.

If the GRR does not recommend any of the With-Project alternatives, final GRR studies may identify some termination costs with the WO alternative—such termination costs will be addressed later in Stage 3 detailed studies. Such termination costs would likely involve features that would be included in ANY recommended plan. Hence, termination costs would likely be a "wash" economically (i.e, not affecting the Net Benefits of a recommended alternative). Hence, termination costs should not affect any of the conclusions in this document.

10.1.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the WO alternative. The economic analysis indicated that flood damage is concentrated in a few sections of the study area, with the vast majority of damage occurring in commercial and industrial structures. The commercial/industrial structures in the floodplain make up 96% of the structure damage from a 1% chance flood event; less than 1% of damage is to residential properties. Of the total damage during a 1% chance flood event, 93% occur in sections 7A and 7B; 4% in section 6; and 3% is divided among sections 7C, 2, and 5. The remaining sections have little or no damage. In addition to overbank flooding structure damage, an economic analysis was performed to determine damage to basements from sewer back-ups into residences and businesses within the sewer-shed of Mill Creek. When Mill Creek rises to certain levels, water backs up through combined sewer overflows (CSOs) and thus back-ups within the sewer system. A map showing sewer backup percentages for the study area can be found in Figure 8.5.1.

With risk and uncertainty factored in, the average annual damage for the WO alternative is estimated at $66,750,000 (project base year 2010). Table 10.1.4.1 displays the damage estimates for selected years.

TABLE 10.1.4.1
Without-Project Damage Estimates (thousands of dollars)

Year	N[5]	Overbank Flooding	Sewer Back-up	Total
2002		$35,409	$9,400	$44,809
2003		$37,200	$9,400	$46,600
2004		$29,000	$9,400	$48,400
2005		$40,800	$9,400	$50,200
2006		$42,600	$9,400	$52,000
2007		$44,400	$9,400	$53,800
2008		$46,200	$9,400	$55,600
2009		$49,800	$9,400	$57,400
2010	1	$51,600	$9,400	$59,200
2011	2	$53,400	$9,400	$61,000
2012	3	$55,200	$9,400	$62,800
2013	4	$57,000	$9,400	$64,600
2014	5	$58,836	$9,400	$66,400
2015	6	$58,836	$9,400	$68,236
2016	7	$58,836	$9,400	$68,236
2017	8	$58,836	$9,400	$68,236
2018	9	$58,836	$9,400	$68,236
2019	10	$58,836	$9,400	$68,236
2024	15	$58,836	$9,400	$68,236
2029	20	$58,836	$9,400	$68,236
2034	25	$58,836	$9,400	$68,236
2039	30	$58,836	$9,400	$68,236
2044	35	$58,836	$9,400	$68,236
2049	40	$58,836	$9,400	$68,236
2054	45	$58,836	$9,400	$68,236
2059	50	$58,836	$9,400	$68,236
Total		$2,914,638	$470,000	**$3,384,638**
Present Value (2010)		$919,953	$150,786	**$1,070,739**
Avg Annual Damage (2010)		$57,350	$9,400	**$66,750**

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The estimated completion schedule varies for the alternatives being evaluated. The year following construction was considered the "alternative base year" for each With-Project alternative. Because the With-Project alternatives have different completion schedules, and therefore different alternative base years, the annual average damage estimate for the WO alternative was recalculated in order to account for discounting over the 50-year project life. This allowed the WO average annual damage to be compared to the average annual damage for

[5] "N" equals the number of years after the completion of construction. The base year (N=1) is the earliest year that any of the with-project alternatives would generate benefits.

each With-Project alternative when calculating the benefits. Table 10.1.4.2 displays the average damages for selected years and the average annual damage based on the alternative base year.

TABLE 10.1.4.2
WO Average Annual Damage Based on Alternative Base Year

Year	Annual Damage	Applicable Alternative				
		RL	NS, NS-2, NS-3	CM, CM-2, TU-2	FW	TU
2010	$59,200,000	1				
2011	$61,000,000	2	1			
2012	$62,800,000	3	2	1		
2013	$64,600,000	4	3	2		
2014	$66,400,000	5	4	3	1	
2015	$68,236,000	6	5	4	2	
2016	$68,236,000	7	6	5	3	
2017	$68,236,000	8	7	6	4	1
2018	$68,236,000	9	8	7	5	2
2023	$68,236,000	14	13	12	10	7
2028	$68,236,000	19	18	17	15	12
2033	$68,236,000	24	23	22	20	17
2038	$68,236,000	29	28	27	25	22
2043	$68,236,000	34	33	32	30	27
2048	$68,236,000	39	38	37	35	32
2053	$68,236,000	44	43	42	40	37
2058	$68,236,000	49	48	47	45	42
2059	$68,236,000	50	49	48	46	43
2060	$68,236,000		50	49	47	44
2061	$68,236,000			50	48	45
2062	$68,236,000				49	46
2063	$68,236,000				50	47
2064	$68,236,000					48
2065	$68,236,000					49
2066	$68,236,000					50
Average Annual Damage		**$66,750,000**	**$67,226,000**	**$67,618,000**	**$68,128,000**	**$68,236,000**
Alternative Base Year		**2010**	**2011**	**2012**	**2014**	**2017**

Notes: discount rate 5.875%; 50-year project life (represented by the number in column); price level in 2002 dollars

During the engineering analysis, the O&M requirements for each alternative were determined. The costs were calculated and included in the cost estimates. Because the O&M requirements were already considered with each alternative, the O&M requirements for the WO alternative would not need to be undertaken. Therefore, the O&M cost for the WO alternative was considered a cost avoided and was included as a benefit to each alternative described below. The average annual O&M cost for the WO alternative was estimated at $34,000. Detailed life-cycle costs for O&M can be found in Appendix V.

10.1.4c Economic Evaluation

The WO alternative is the baseline or "No Action" alternative that provides the basis of comparison for all other alternatives. This alternative includes features and other items that would likely come about, even without Federal involvement or funding. The WO alternative was assumed to have no net costs or benefits associated with it. Any change that comes about as a result of implementing a With-Project alternative, such as a reduction in flood related damages or an incremental change in O&M cost, would be considered a cost or a benefit compared to the WO.

10.2 TOTAL RELOCATION (RL)

10.2.1 Description and Features

The RL alternative considers the relocation of all businesses and residences in the existing 4% ("25-year") chance floodplain of Mill Creek. The alternative would include both the purchase of properties and compensation for moving and relocation expenses for current property owners, residents, and tenants. Maps showing buildings and pavements to be removed for the RL alternative can be found in Appendix VII.

For the RL alternative, detailed mapping showing the 4% chance floodplain along the entire length of Mill Creek was used to identify the properties to be acquired (refer to maps in Appendix VI for 4% chance floodplain). The existing residential and commercial structures (Table 10.2.1.1) would be demolished to ground (grade) level. The sites would be backfilled, compacted, graded, and seeded. Construction of the RL alternative would begin in 2007 and be completed in 2009.

TABLE 10.2.1.1
Demolition Quantities for RL Alternative

Section	Residential Structures	Commercial Structures	Roadway (yd^2)	Parking (yd^2)
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	114	8	32,000	25,000
5	0	0	0	0
6	188	16	34,500	46,000
7	20	67	79,800	99,900
Total	**322**	**91**	**146,300**	**170,900**

Local street pavements and local-service utilities, excluding major thoroughfares and major transmission lines, would be removed within the 4% chance floodplain. These local pavements and local utilities would no longer be needed.